Remote Investigation of Trace Organics using Cryoluminescence (RITOC), Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

Detection of organics on solar system bodies and their spatial distribution are fundamental capabilities required to meet NASA strategic goals. This proposal addresses the need for remote detection and classification of trace concentrations of organic compounds on the surfaces of Ocean and Icy Worlds including Europa, Enceladus, Titan, as well as other cold worlds. Mars 2020 SHERLOC conducts vibrational spectroscopy at standoff about 6 cm due to low cross-sections about 10^8 to 10^{10} times lower than fluorescence.

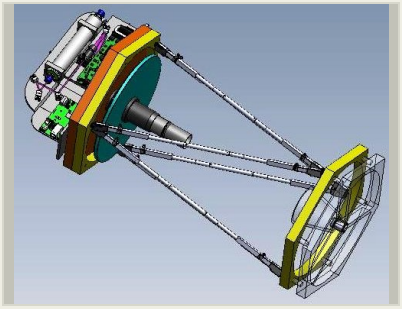
At temperatures below 160K, the ability to measure vibrational information of organic compounds with vastly increased cross-sections, equivalent to room temperature fluorescence or greater, was demonstrated in the publication in 2011 by P.V. Johnson of JPL and others. They showed that low temperature fluorescence exhibits resolvable vibrational bands that provide structural details such as the arrangement of methyl groups and the presence and variability of functional groups. This enables detection at far greater standoff distances and lower concentrations with anticipated limits of detection from below 1 ppb at standoff distances of 10's of meters to about 1 ppm at 10's of kilometers.

Using existing cryogenic facilities, deep UV lasers, and related optical and vacuum hardware at Photon Systems, we propose in Phase I to quantify the absolute cross-sections of relevant organic materials and understand cryoluminescence spectral features at low temperatures. We will generate a radiometric photon budget model to predict the limits of detection versus standoff distance for a small, light-weight, low-power, RITOC instrument. The Phase I effort is intended to provide the proof-of-concept for the proposed standoff RITOC instrument, increasing the TRL from about 1 to 2. The Phase II effort will be focused on developing and demonstrating the RITOC instrument in terrestrial settings at distances up to 100 m, bringing RITOC instrument TRL up to about 3.

Anticipated Benefits

The RITOC method and instrument has a broad range of potential applications for NASA for measuring the type and distribution of trace organic chemical and biological materials on surfaces from small to medium size fixed landers. rovers, and potentially on low altitude flyby instruments of Ocean and Icy Worlds. This technology is also applicable for terrestrial field applications including Antarctica and the Artic as well as other harsh environments.

Typical Non-NASA applications of RITOC include detection of unknown chemicals or biological materials on surfaces at remote or standoff distances. Non-NASA applications include situational awareness of surrounding chemical, biological, and explosives hazards for first responders in both military and



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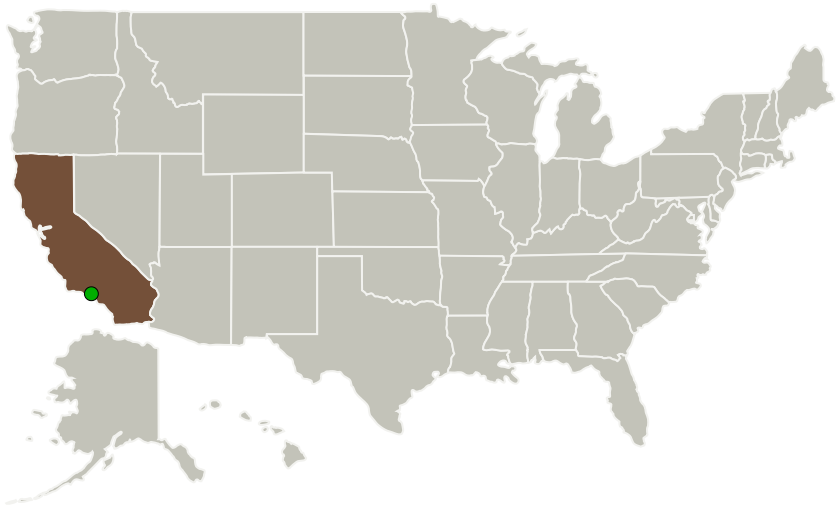
civilian environments. In addition, the same instrument and technology is applicable to cleaning validation in pharmaceutical, food, and chemical manufacturing and environmental monitoring.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Photon Systems, Inc.	Lead Organization	Industry	Covina, California
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations
California

Project Transitions

July 2018: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Photon Systems, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

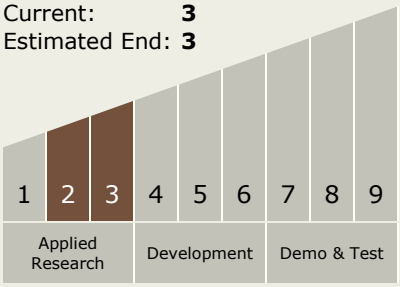
Carlos Torrez

Principal Investigator:

William F Hug

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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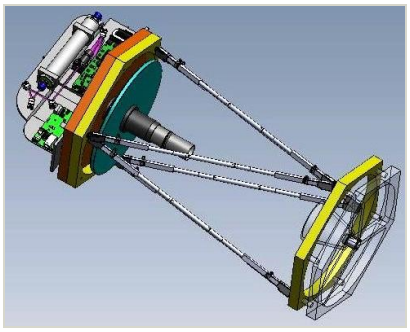
February 2019: Closed out

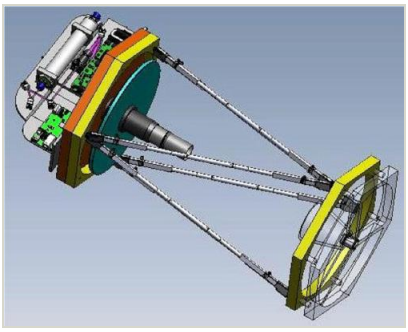
Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137896)*

Images



Briefing Chart Image
Remote Investigation of Trace Organics using Cryoluminescence (RITOC), Phase I
(https://techport.nasa.gov/image/128441)



Final Summary Chart Image
Remote Investigation of Trace Organics using Cryoluminescence (RITOC), Phase I
(https://techport.nasa.gov/image/128369)

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.5 Lasers

Target Destinations

Mars, Others Inside the Solar System